NOTE

This Microfiche meets the quality requirements of the American National Standard for Microfiche of Documents (ANSI PH5.9-1975). However, because of imperfections in the document from which it was made, it contains images that are illegible or difficult to read. The source document for this microfiche is the best copy that could be obtained prior to filming.

Congressional Information Service, Inc.
Washington, D.C.

99th Congress
2d Session

JOINT COMMITTEE PRINT

No. 19

JOINT HEARINGS ON ASSURED ACCESS TO SPACE DURING THE 1990'S

REPORT

PREPARED BY THE

RESEARCH AND DEVELOPMENT SUBCOMMITTEE

OF THE

COMMITTEE ON ARMED SERVICES

AND THE

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY

[Committee on Science and Technology Serial N]

HOUSE OF REPRESENTATIVES
NINETY-NINTH CONGRESS
SECOND SESSION

NOTICE
THIS REPORT WAS PREPARED PRIOR TO THE SHUTTLE CHALLENGER ACCIDENT AND DOES NOT REFLECT THE EFFECT OF THE ACCIDENT ON THE SUBJECT OF THE REPORT.

JANUARY 1986

U.S. GOVERNMENT PRINTING OFFICE
59-719 O WASHINGTON : 1986

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

H702-7
H202-10

HOUSE COMMITTEE ON ARMED SERVICES

NINETY-NINTH CONGRESS, 2d SESSION

LES ASPIN, Wisconsin, *Chairman*

MELVIN PRICE, Illinois, *Chairman Emeritus*
CHARLES E. BENNETT, Florida
SAMUEL S. STRATTON, New York
BILL NICHOLS, Alabama
DAN DANIEL, Virginia
G.V. (SONNY) MONTGOMERY, Mississippi
RONALD V. DELLUMS, California
PATRICIA SCHROEDER, Colorado
BEVERLY B. BYRON, Maryland
NICHOLAS MAVROULES, Massachusetts
EARL HUTTO, Florida
IKE SKELTON, Missouri
MARVIN LEATH, Texas
DAVE McCURDY, Oklahoma
THOMAS M. FOGLIETTA, Pennsylvania
ROY DYSON, Maryland
DENNIS M. HERTEL, Michigan
MARILYN LLOYD, Tennessee
NORMAN SISISKY, Virginia
RICHARD RAY, Georgia
JOHN M. SPRATT, JR., South Carolina
FRANK McCLOSKEY, Indiana
SOLOMON P. ORTIZ, Texas
GEORGE (BUDDY) DARDEN, Georgia
TOMMY F. ROBINSON, Arkansas
ALBERT G. BUSTAMANTE, Texas
WILLIAM L. DICKINSON, Alabama
G. WILLIAM WHITEHURST, Virginia
FLOYD SPENCE, South Carolina
MARJORIE S. HOLT, Maryland
ELWOOD H. (BUD) HILLIS, Indiana
ROBERT E. BADHAM, California
BOB STUMP, Arizona
JIM COURTER, New Jersey
LARRY J. HOPKINS, Kentucky
ROBERT W. DAVIS, Michigan
KEN KRAMER, Colorado
DUNCAN L. HUNTER, California
THOMAS F. HARTNETT, South Carolina
DAVID O'B. MARTIN, New York
JOHN R. KASICH, Ohio
WILLIAM CARNEY, New York
LYNN MARTIN, Illinois
HERBERT H. BATEMAN, Virginia
MAC SWEENEY, Texas
BEN BLAZ, Guam

G. KIM WINCUP, *Staff Director*

RESEARCH AND DEVELOPMENT SUBCOMMITTEE

MELVIN PRICE, Illinois, *Chairman*

DAVE McCURDY, Oklahoma
DENNIS M. HERTEL, Michigan
FRANK McCLOSKEY, Indiana
GEORGE (BUDDY) DARDEN, Georgia
CHARLES E. BENNETT, Florida
BILL NICHOLS, Alabama
RONALD V. DELLUMS, California
WILLIAM L. DICKINSON, Alabama
JIM COURTER, New Jersey
ROBERT E. BADHAM, California
ROBERT W. DAVIS, Michigan
BOB STUMP, Arizona

ANTHONY R. BATTISTA, *Professional Staff Member*
CARL T. BAYER, *Professional Staff Member*

COMMITTEE ON SCIENCE AND TECHNOLOGY

DON FUQUA, Florida, *Chairman*

ROBERT A. ROE, New Jersey
GEORGE E. BROWN, JR., California
JAMES H. SCHEUER, New York
MARILYN LLOYD, Tennessee
TIMOTHY E. WIRTH, Colorado
DOUG WALGREN, Pennsylvania
DAN GLICKMAN, Kansas
ROBERT A. YOUNG, Missouri
HAROLD L. VOLKMER, Missouri
BILL NELSON, Florida
STAN LUNDINE, New York
RALPH M. HALL, Texas
DAVE McCURDY, Oklahoma
NORMAN Y. MINETA, California
MICHAEL A. ANDREWS, Texas
BUDDY MacKAY, Florida **
TIM VALENTINE, North Carolina
HARRY M. REID, Nevada
ROBERT G. TORRICELLI, New Jersey
RICK BOUCHER, Virginia
TERRY BRUCE, Illinois
RICHARD H. STALLINGS, Idaho
BART GORDON, Tennessee
JAMES A. TRAFICANT, JR., Ohio

MANUEL LUJAN, JR., New Mexico*
ROBERT S. WALKER, Pennsylvania
F. JAMES SENSENBRENNER, JR., Wisconsin
CLAUDINE SCHNEIDER, Rhode Island
SHERWOOD L. BOEHLERT, New York
TOM LEWIS, Florida
DON RITTER, Pennsylvania
SID W. MORRISON, Washington
RON PACKARD, California
JAN MEYERS, Kansas
ROBERT C. SMITH, New Hampshire
PAUL B. HENRY, Michigan
HARRIS W. FAWELL, Illinois
WILLIAM W. COBEY, JR., North Carolina
JOE BARTON, Texas
D. FRENCH SLAUGHTER, JR., Virginia
DAVID S. MONSON, Utah

HAROLD P. HANSON, *Executive Director*
ROBERT C. KETCHAM, *General Counsel*
REGINA A. DAVIS, *Chief Clerk*
JOYCE GROVE FREIWALD, *Republican Staff Director*

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

BILL NELSON, Florida, *Chairman*

GEORGE E. BROWN, JR., California
MICHAEL A. ANDREWS, Texas
ROBERT G. TORRICELLI, New Jersey
BART GORDON, Tennessee
JAMES H. SCHEUER, New York
HAROLD L. VOLKMER, Missouri
NORMAN Y. MINETA, California
RALPH M. HALL, Texas

ROBERT S. WALKER, Pennsylvania
JAN MEYERS, Kansas
ROBERT C. SMITH, New Hampshire
JOE BARTON, Texas
D. FRENCH SLAUGHTER, JR., Virginia
DAVID S. MONSON, Utah

Dr. RADFORD BYERLY, *Staff Director*
Dr. HARRY S. (TERRY) DAWSON, Jr., *Technical Consultant*

---

*Ranking Republican Member.
**Serving on Committee on the Budget for 99th Congress.

LETTER OF TRANSMITTAL

Hon. Don Fuqua, Chairman
Committee on Science and Technology
and
Hon. Les Aspin, Chairman
Committee on Armed Services
Washington, DC 20515

Dear Mr. Chairmen:

Because of the overriding importance of the availability of an adequate and reliable space launch capacity to the successful conduct of key national security and civil space programs, our two Subcommittees held three days of joint hearings on the subject of Assured Access to Space in the 1990s.

These hearings were held between July 23 and 25, 1985, and testimony was received from 10 current and past senior government space officials.

This report summarizes the testimony that was received as well as the conclusions and recommendations that were reached by our Subcommittees. One conclusion is that the approved inventory of national space launch capacity (made up of a four Orbiter fleet and several ELVs per year) provides little flexibility for accommodating the disruptions that would be caused by an accident involving an Orbiter.

Accordingly, the Subcommittees have recommended that NASA and the Department of Defense jointly study the feasibility of adopting and implementing a policy that the United States maintain a national space launch capacity that is adequate and flexible enough to accommodate the extended unavailability or total loss of a single Space Shuttle Orbiter with no major impact on the U.S. launch manifest of national security, civil government, foreign, and commercial payloads.

Though this report was completed before the accident involving the Space Shuttle Challenger, and does not reflect the full impact of that accident, we believe that the report highlights important issues that must be resolved in coming years as the Nation moves to recover from the significant impacts of this tragic accident.

The accompanying report was prepared by Dr. Harry S. Dawson, Jr., of the Subcommittee on Space Science and Applications and Carl T. Bayer of the Subcommittee on Research and Development. We commend the conclusions and recommendations to your attention.

Sincerely,

Melvin Price

HON. MELVIN PRICE, Chairman
Subcommittee on Research
and Development
Committee on Armed Services

Bill Nelson

HON. BILL NELSON, Chairman
Subcommittee on Space Science
and Applications
Committee on Science and Technology

CONTENTS

PAGE

Summary, Conclusions and Recommendations 1
A. Summary 1
B. Conclusions and Recommendations 3
I. Introduction 7
II. Background 9
III. Summary of Testimony 11
IV. Major Issues
A. Future Launch Demand 17
B. Adequacy of Existing Launch Capacity 19
C. Consequences of Unavailability of an Orbiter 21
D. Alternatives for Enhancing Space Launch Capacity 22
1. Build A Fifth Space Shuttle Orbiter 23
2. Build Additional Complementary Expendable Launch Vehicles (CELVs) 24
3. Utilize Some Small Expendable Launch Vehicles (ELVs) 25
4. Develop and Use Large Heavy-Lift Expendable Launch Vehicles 25
5. Develop A New Generation of Transatmospheric Vehicles (TAVs) 26
E. National Space Transportation and Support Study 27
F. Priority Allocations Between Defense and Civil Users .. 28

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. Summary

The following is a summary of the major points that were raised during the three days of hearings.

1. During the first half of the 1990s, user demand for access to space should equal the equivalent of between 26 and 32 fully loaded Space Shuttle launches per year. Included in the 32 Shuttle equivalent launches per year baseline for the post-1992 period are the following:

- o Space Station related launches -- 9 to 10
- o All other civil launches -- 6 to 7
- o Strategic Defense Initiative related launches -- 5
- o All other DOD launches -- 11.

2. Space launch demands during the latter half of the 1990s will be greater than during the first half, but are difficult to quantify with precision because of uncertainties in: 1) the rate at which Space Station activities will expand; 2) the rate at which commercial development and use of space will materialize; and 3) whether or not the Strategic Defense Initiative will be approved for deployment.

3. The annual launch capability of the Space Shuttle fleet in the 1990 timeframe should be as follows:

- o 24 flights per year for a four Orbiter fleet, with an ability to surge temporarily to a rate of 28 flights per year,
- o 30 flights per year for a five Orbiter fleet, and
- o 15 to 20 flights per year for a three Orbiter fleet (i.e., with one of the current fleet of four Orbiters out of service), with an ability to surge temporarily to a rate of 20 to 24 flights per year.

4. In addition to its use of the Space Shuttle during the early 1990s, the Defense Department currently plans to launch two complementary expendable launch vehicles (CELVs) and two modified Titan II ICBMs each year. This will add the equivalent of about 2 1/2 Space Shuttle flights per year to national launch capacity.

5. CELV use is scheduled to stop in 1993 and Titan II launches are scheduled to continue through 1995.

6. The Defense Department argues that CELVs are necessary to provide the "flexibility and versatility" required by some national security missions as well as ensuring that the most important national security payloads are not dependent on a single launch system for reaching orbit.

7. The Defense Department believes that it is more efficient to use small ELVs (like modified Titan II ICBMs) rather than a dedicated Space Shuttle for small launch-on-demand satellites or for placing small satellites into unique or low-traffic-volume orbits.

8. Dr. Hans Mark expressed the view that a major factor in DOD's desire to use expendable launch vehicles is a need to maintain operational control over the means for orbiting key national security payloads. Other witnesses attached less significance to this factor.

9. The actual launch capacity of the Space Shuttle fleet could be adversely affected by the fact that there is no backup to the single 747 aircraft used to transport Orbiters. NASA is currently exploring means of correcting or mitigating this situation.

10. If space launch capacity is required in addition to that which can be provided by the existing Space Shuttle fleet and planned ELV launches, it could be obtained from the following:

- o Building a fifth Space Shuttle Orbiter,
- o Procuring additional CELVs,
- o Utilizing additional small ELVs (such as modified Titan II ICBMs, Atlases or Thor-Deltas), and
- o Developing and using a large heavy-lift ELV employing Space Shuttle components.

11. The Defense Department estimates that the total relative direct and indirect costs (in FY 85 dollars) which it will incur in using various launch vehicles are as follows:

- o Roughly $30 million per flight for modified Titan II launch vehicles (with a payload carrying capability of one-fourth to one-fifth that of the Space Shuttle),
- o About $114 million per flight for the Space Shuttle (excluding other possible general overhead costs paid for by NASA), and
- o About $122 million per flight for CELVs (with a paload carrying capability approximately equal to that of the Space Shuttle).

12. Because of severe budgetary constraints, there currently is little support within the Administration for the procurement of a fifth Space Shuttle Orbiter. With a FY 1988 production start and a 1992 delivery, the vehicle would cost about $2.2 billion.

13. The Defense Department believes that it is too early to determine if additional CELVs will be required beyond the 10 intended for use through 1993. The principal determinants will be the extent to which space launch demand levels grow during the 1990s and the demonstrated flight rate capability of the Orbiter fleet.

14. Department of Defense witnesses noted that their projected utilization of small ELVs is low enough that it would not be economical to consider maintaining more than one production line for such boosters.

15. It was commonly agreed by the witnesses at the hearing that there eventually will be a requirement to develop a heavy-lift ELV with a payload capability in the 100,000 to 200,000 pound range. Most witnesses expressed the belief that since it takes longer to develop a payload than a space booster, development of a heavy-lift launch vehicle should be postponed until a firm payload requirement materializes. Under Secretary Aldridge of the Air Force estimated that the cost of each heavy-lift launch vehicle would be roughly twice the cost of a CELV.

16. The Administration is about to initiate a program which, if successful, could lead to the development of a revolutionary new type of space launch vehicle that employs jet engines as its principal means of propulsion. However, most witnesses agree that a Transatmospheric Vehicle (TAV) with the payload carrying capability of the Space Shuttle could not be available before the year 2000.

17. If a Space Shuttle Orbiter were destroyed in an accident, it would take about three and one-half years to replace the lost launch capacity with expendable launch vehicles or about five years to build a replacement Orbiter.

18. It is generally accepted within the Administration that the Defense Department will always have priority over all other users whenever available launch capacity is inadequate to meet the total needs of all users.

19. The Administration has initiated a comprehensive joint NASA/DOD study of future space launch requirements and capabilities. At the time these hearings began, this Space Transportation and Support Study was intended to cover the period 1995 and beyond and to report results in May of 1986.

B. Conclusions and Recommendations

After analyzing all of the testimony and views that were offered at the hearings, the Space Science and Applications Subcommittee of the Committee on Science and Technology and the Research and Development Subcommittee of the Committee on Armed Services have reached a number of conclusions and, where appropriate, made related recommendations.

1. The best available estimates of likely space launch demands for the post-1992 timeframe range between 26 and 32 Shuttle-equivalent flights per year. The Subcommittees believe that, at the low end of this range, the currently programmed capacity provided by a four Orbiter fleet augmented by two CELVs and two modified Titan II ICBMs per year would be adequate, but taut and constrained. At the high end, the available capacity would be woefully inadequate.

Based on past history, launch demands for the first half of the 1990s are more likely to be closer to the low end of this range. Launch demands for the later half of the 1990s will almost certainly exceed those of the first half of the decade, but it is impossible to accurately project what launch rates will be that far into the future.

2. The Subcommittees believe that concentrating the entire space launch capability of the United States in a fleet of four Orbiters and a few ELVs per year provides little flexibility for accommodating the disruptions that would be caused by an unforeseen accident, for example, one causing the extended unavailability of a single Orbiter. With the space launch assets currently planned to be available in the early 1990s, the sustained downtime or total loss of a single Orbiter would produce a substantial reduction in this country's total launch capacity which could not be replaced for 3 to 5 years. This would cause serious disruptions and delays in many civil space launches and possibly in some national security space projects as well.

One possible solution to this problem would be for the Administration to adopt and implement a policy that would require the launch capacity of the United States to be adequate and flexible enough to accommodate the extended unavailability or total loss of a single Space Shuttle Orbiter with no major impact on the U.S. launch manifest of national security, civil government, foreign, and commercial payloads. During the hearings, both Under Secretary of the Air Force Aldridge, and NASA Associate Administrator for Space Flight Moore agreed that such a policy should be adopted. Under Secretary Aldridge noted further that this was the argument used by the Defense Department to justify use of CELVs during the 1988-1993 timeframe.

The Subcommittees recommend that NASA and the Defense Department join together to fully analyze the feasibility and likely budgetary and programmatic impacts of adopting or not adopting such a policy and report the results of this analysis to the Subcommittees by August 1, 1986.

3. The Subcommittee are concerned that NASA does not have a back-up to the single 747 aircraft that is used to transport Space Shuttle Orbiters. The loss or other unavailability of this aircraft could have serious ramifications on the launch capacity of the Space Shuttle fleet.

The Subcommittees recommend that NASA fully analyze the alternatives for reducing the impact of any unavailability of the single 747 transport aircraft and report the results of this analysis to the Subcommittees by August 1, 1986.

4. The Subcommittees are strongly supportive of current Administration plans to initiate an exploratory research and development program that hopefully will lead to the successful development of a new generation of space launch vehicles that employ jet engines as their principal means of propulsion. The Subcommittees believe that if such Trans-atmospheric Vehicles are found to realize their promise, their eventual deployment could revolutionize the utility, ease of access, and economics of space activities for all civil and national security users.

5. The consensus of witness testimony was that the earliest that a next-generation replacement of the Space Shuttle fleet could become available is about the year 2000. Given that the Space Shuttle fleet will likely have to serve as the principal means of access to space throughout the 1990s, and that it appears that available national launch capacity could become saturated in the early 1990s, it is possible that it may be prudent to procure an additional Orbiter at some point in the future. The Subcommittees are concerned that if a decision is not reached soon on building an additional Space Shuttle Orbiter, the production base will decline to such an extent that the country may no longer be able to build the vehicle at a reasonable cost.

The Subcommittees recommend that the Administration make a final decision during FY 1986 whether or not to procure an additional Space Shuttle Orbiter before the production line totally shuts down.

6. The Subcommittees are concerned that the Administration may be over estimating the level of launch priority that will be enjoyed by the Defense Department in the event that space launch capacity becomes seriously constrained, for example, through the loss of an Orbiter. It is clear that in a time of national emergency, defense-related payloads would have complete priority. However, in peacetime the Defense Department could find that through congressional mandates it may have to share more equally in the loss of cpacity with important civil initiatives.

7. The Subcommittes are pleased that NASA and the Defense Department are working closely together to define future space launch needs and the best means of providing for those needs. The Subcommittees intend that both agencies maintain a national perspective in approaching this subject.

8. The Subcommittees are also pleased that both NASA and the Air Force quickly and decisively reacted to the concerns raised by Subcommittee Members regarding shortcomings in the scope and schedule of the joint National Space Transportation and Support Study. Specifically, during the last day of the hearings, NASA and the Air Force agreed to modify the study as follows:

- Move forward the start of the timeframe of the study from 1995 to 1992,

- Identify and thoroughly evaluate alternative launch vehicles and facility procurement and operating options that could provide sufficent space launch capacity so that the sustained unavailability or total loss of a single Space Shuttle Orbiter could be accommodated with no major impact on the U.S. launch manifest of national security, civil government, foreign, and commercial payloads, and

- Brief the appropriate congressional committees on tentative conclusions of the study by the time that the President's FY 1987 budget is transmitted to the Congress.

I. Introduction

In the 28 years since the launching of the first United States satellite in January of 1958, outer space has become increasingly important to the national security, economic well-being, quality of life, and rate of technological growth of the United States. Accordingly, it has become increasingly important for the United States to maintain the means for achieving adequate and reliable access to space.

The Space Shuttle is now well on its way to operational maturity and is scheduled to be capable of making 24 flights per year by 1989. However, during the past year, a growing number of space transportation issues have arisen. These issues have included: concerns over uncertainty in space launch demands for the 1990s; the adequacy of a four-Orbiter Space Shuttle fleet; the potential need for a new generation of "heavy-lift" launch vehicles; and the stated DOD requirement to augment the Space Shuttle with a certain number of expendable launch vehicles.

Being concerned that these issues had not been adequately addressed, the Space Science and Applications Subcommittee of the Committee on Science and Technology and the Research and Development Subcommittee of the Committee on Armed Services decided to hold a series of hearings to focus greater attention on these matters. Because of the close interrelationship between the needs for space transportation by civil and military programs, the leadership of the two Subcommittees thought that it would be best if these hearings were held jointly. Accordingly, the three-days of hearings that were conducted from July 23 through July 25, 1985, were conducted jointly by the two Subcommittees.

In his opening statement, Chairman Bill Nelson (D-FL) of the Space Science and Applications Subcommittee stated:

> "In the past year NASA and the Defense Department have reached agreements on how to best meet the space launch needs for the rest of this decade. Additionally, work has begun on studies of next generation space transportation systems. However, these next generation systems will largely not be available until after the year 2000. Accordingly, decisions must soon be reached on how existing systems and technologies will be procurred and operated to meet all of the space transportation needs of the 1990s. This subject is the focus of these hearings."

Congressman Bob Walker, (R-PA), the Ranking Republican Member of the Space Science and Applications Subcommittee, added in his opening statement:

> "It concerns me, and other Members of our Space Subcommittee, that neither NASA nor the Air Force seems to have taken a good hard look at launch requirements for the period of the next ten years. I strongly support both the Space Station and the Strategic Defense Initiative, but we do not see any missions being added to the manifest to support those two projects."

Chairman Melvin Price (D-IL), of the Research and Development Subcommittee, stated in his opening statement:

> "This joint hearing on assured access to space in the 1990s is designed to explore not only defense launch demands but those of all other users. I am extremely interested in this issue as it will help the Armed Services Committee to focus defense priorities with other national interests. We are clearly in a time where this country cannot pass up opportunities such as this to achieve needed fiscal efficiencies."

Congressman William L. Dickinson (R-AL), the Ranking Republican Member of the Research and Development Subcommittee, added in his opening remarks:

> "We have had very little success in the past with joint programs among the defense services.... In this hearing we are talking about not only the three defense budgets, but other interested parties also that don't come under the aegis of the direction and control of the Secretary. I think it is an excellent forum to begin to address the issue, and I am very pleased that it has been called...."

II. Background

In recent years, there have been a growing number of unresolved space transportation issues of concern to the Congress. The intent of the joint hearings on assured access to space during the 1990s was to begin to sharpen the focus of the Administration and Congress so that these issues will receive adequate attention and, as a result, can be resolved approprately. The paragraphs that follow highlight some of the more important issues that were of concern to the Congress before the start of the hearings.

From the time that President Nixon approved the development of the Space Shuttle in 1972, the intent of the government has been to eventutally phase out the use of expendable launch vehicles (ELVs) and to depend on the Shuttle for essentially all access to space.[1]

As the time approached for all ELV production lines to be shut down, however, the Department of Defense had second thoughts and began to argue in favor of continuing to build and launch a limited number of ELVs with a payload capability equivalent to that of the Space Shuttle. This system became known either as the Complementary Expendable Launch Vehicle (CELV) or the Titan 34D-7. Disagreements within the Administration on this issue were resolved in February 1985 with the issuance of a National Security Decision Directive (NSDD 164) by President Reagan. This directive indicated that the Defense Department will rely principally on the Space Shuttle and commit to use at least one-third of the Shuttle's available flights during the next ten years. On the other hand, the directive also permits the Air Force to procure ten large ELVs and launch them at a rate of approximately two per year during the period 1988-1992.

While Administration and Congressional officials have been discussing whether or not Federal use of ELVs should be terminated, the debate has continued over whether or not NASA should procure a fifth Space Shuttle Orbiter. To extend the period of time available to make a final procurement decision on the fifth Orbiter, in 1983 the Congress approved the initiation of a "structural spares" program for the Space Shuttle. The structural spares program was intended to produce selected major structural components of an Orbiter which could be used as replacement parts if an operational Orbiter were to sustain structural damage in an accident.[2]

---

[1](a) Statement issued by President Nixon in San Clemente, California, on January 5, 1972.
(b) National Security Council Directive 42, Signed by President Carter on October 10, 1978. (Classified.)

[2]FY 1984 NASA Authorization, Volume II, Hearings Before The Subcomittee on Space Sceince and Applications of the Committee on Science and Technology, U.S. House of Representatives, Ninety-Eighth Congress, First Session, February and March, 1983.

But, the basic objective of the structural spares program was to maintain a significant level of manufacturing activity on the Orbiter production line through 1986. In earlier hearings, the Space Science and Applications Subcommittee had raised the concern that a final decision on production of a fifth Orbiter has not yet been reached, while the time is fast approaching when Orbiter production activities will be terminated.[3]

The Subcommittee has expressed concern that if a decision is not made soon, the loss of prime and second-tier contractors may make the vehicle prohibitively expensive to produce at a later date.[4]
One key factor frequently cited by NASA officials as pivotal in deciding whether or not a fifth Orbiter should be built is the tainty in the demand for future space launch activity. A major unknown in this regard is the likely demand for space transportation services that will be required to support activities of the Space Station and the Strategic Defense Initiative (SDI) programs. In fact, prior to these hearings on assured access to space during the 1990s, the Administration had not publically issued any definitive estimates of Space Station and SDI-related launch requirements.

Another unknown is whether or not the Nation will require the availability of "heavy lift" ELVs--that is, a class of launch vehicles with payload carrying capabilities substantually greater than those of the Space Shuttle or any other currently available launch vehicle. It is generally thought that the most likely use for such vehicles will be in supporting the SDI program. If it is determined that such vehicles will be required, questions then arise as to when they should be made available and how much payload carrying capability they should have.

A final issue of concern relates to the joint NASA/DOD National Space Transportation and Support Study that was just getting under way in early 1985. The principal thrust of this study was to focus on the development of a second generation space transportation and support system. The time frame for the study was to begin in 1995 and extend beyond the year 2000. A concern of some Members was that a "second generation" space transportation system may not be available before the year 2000. Therefore, it did not appear that the study was going to adequately focus on a key issue, namely what space transportation assets would be required and should be maintained to meet the demands of the 1990s?

---

[3] Authorizing Appropriatons to the National Aeronautics and Space Administration for Fiscal Year 1986. Legislative Report #99-32, March 28, 1985.

[4] Review of Space Shuttle Requirements, Operations, and Future Plans. Report, Committee on Science and Technology, U.S. House of Representatives, 98th Congress, Serial HH, October 1984.

III. Summary of Testimony

During the three days of hearings, a total of ten witnesses testified on various issues relating to assured access to space. The first day of hearings focused on emerging space launch demands for the 1990s, while the next two days concentrated on various options for satisfying these launch demands.

The following is a brief summary of each witness' testimony:

Chester M. Lee, Director of NASA's Customer Services office, initially testified that during the 1992-1995 time frame, civil users (i.e., NASA, NOAA, foreign and commercial customers) will require an average of 15 Space Shuttle launches per year (including the launches required to support Space Station useage). Later, during a question and answer period, he increased this estimate to 16 launches per year. However, he added that "based on actual experience with U.S. Government payload projections and the current national budgetary climate...some of the projected payloads will not get past the planning stage and others will not arrive on schedule." He noted further that: "a 10-15 percent reduction of the overall requirement is not, in my opinion, able."

Philip E. Culbertson, Associate Administrator for NASA's Space Station Office, testified that about 12 flights (during a 12-18 month period) would be required to place the Space Station into orbit. Thereafter, about 9 to 10 flights per year would be required to provide for logistic support and to move users and their cargo to and from the Station.

Brigadier General Donald J. Kutyna, Director of the Air Force Space Systems and Command, Control, and Communications Office in the Pentagon, testified that:

- From 1980 through 1984, DOD launched the equivalent of slightly less than four Space Shuttle cargo bays worth of payloads each year,
- During the last half of the 1980s, DOD expects to launch the equivalent of approximately 9 Space Shuttle cargo bays worth or payloads each year,
- For the early 1990s, DOD expects this to grow to approximately 11 Space Shuttle equivalents per year, and
- During the last half of the 1990s, DOD projects an average launch demand of about 12 Space Shuttle equivalents per year.

General Kutyna indicated that these launch projections exclude Strategic Defense Initiative related activity and noted that they assume "perfect manifesting" of the Space Shuttle (i.e., all launches will be fully loaded). General Kutyna added that to the extent that scheduling, loading, and orbital requirements do not permit perfect cargo manifesting on the Space Shuttle, additional launches will be required.

Lt. General James A. Abrahamson, Director of the Strategic Defense Initiative Organization in the Office of the Secretary of Defense, testified that his estimate of the space launch rates required to support the SDI program would be as follows:

- o One equivalent Space Shuttle flight per year during the basic research phase (currently estimated to last through 1991),

- o Five equivalent Space Shuttle flights per year during the development phase (which could start in 1992), and

- o If a decision is made to deploy an SDI system, the number of annual Space Shuttle equivalent flights required to conduct the deployment activities "would equal or significantly exceed the total current and projected national launch capability."

In concluding his statement, General Abrahamson noted:

> "Since our future launch requirements are so indeterminate at this time, one of our top level objectives is flexibility. We must have the ability to satisfy a dynamic range of lift requirements, launch rates, and schedules. It is doubtful that a single launch vehicle will satisfy these requirements and it is likely that a family of vehicles may be needed."

General Robert T. Herres, Commander in Chief of the North American Aerospace Defense Command and Commander of the Air Force Space Command, testified from the perspective of an operator of military space systems who is dependent on having assured access to space. Among the key points made by General Herres were the following:

- o "In the near term, our launch requirements are well defined, and generally satisfied."

- o "The Nation and the Air Force are firmly committed to the use of the Space Transportation System, the Shuttle, as our principal means of launching payloads into Earth orbit."

- o "Our plan to retain a launch capability to complement the Shuttle is based on years of intensive consideration.... Our current approach is to procure a limited number of Titan 34D-7 complementary expendable launch vehicles (CELVs) for use in the FY 1989-1993 time period and to use Atlas or converted Titan II vehicles launched from the West Coast when appropriate through 1995."

- o The cost of maintaining this "complementary launch strategy...is relatively low, since it is the difference between launching a limited number of DOD satellites on CELVs, or launching them on the Shuttle."

- o "I believe that the current launch strategy of primary reliance on the Space Shuttle, complemented by expendable launch vehicles provides a reasonable balance between operational imperative and cost."

- o "It seems to me that the time has passed during which we might have built a fifth Orbiter. The resources now needed for a fifth Orbiter may be better devoted to new technology and options which afford us more flexibility and versatility."

- o "As our dependence on space continues to expand, we need to think through the problem of space launch even more carefully to achieve a comprehensive space launch strategy.... This study, the national space transportation and support study, has begun and will report its findings to the President within a year."

Dr. Hans Mark, Chancellor of the University of Texas System and former Deputy Administrator of NASA and Under Secretary of the Air Force, testified:

> "It is my considered opinion that there is no technical reason why the entire U.S. space launch capability should not be vested in the Space Shuttle fleet."

He went on to state his belief that arguments made in favor of creating the CELV are "flawed". And further:

> "The real issue...is not reliability or vulnerability. ...[It] is operational control of the launch vehicles.... It is unacceptable that the people in charge of the most important space payloads we fly do not have operational control over their own space vehicles."

Dr. Mark concluded this part of his testimony by stating:

> "The right solution, in my view, would be for the military to exercise operational control over some fraction of the Shuttle fleet and a greater degree of control at the Shuttle launch sites. Also, I would have preferred to see the military develop a Shuttle derived launch vehicle that would have the growth capability to meet the heavy lift requirements that will surely result from the work now going on in the area of strategic defense."

Regarding the need for a fifth Orbiter, Dr. Mark testified that:

> "A fifth Space Shuttle Orbiter can only be justified on the grounds that Space Station and strategic defense requirements will ultimately increase space operations to the point where a fifth Orbiter will be necessary.... We should take the risk now, anticipate the need, and build the fifth Orbiter."

Additionally, he stated a belief that all Titan, Delta, and Atlas launch vehicles (including the Titan class CELV) should be "phased out by the 1990s."

Honorable Edward C. Aldridge, Jr., Under Secretary of the Air Force, testified that NASA and the Air Force have unique missions and unique requirements that "cannot always be solved with a single system." He stated that the Defense Department will depend on the Space Shuttle as its "primary means of access to space," but expressed a believe that "it is necessary to complement the Shuttle with a limited fleet of expendable launch vehicles" in order to provide an added measure of assured access to space for national security payloads.

He went on to note:

> "The additional national capability derived from maintaining an ELV industrial base and an ELV launch capability provides not only a complement to the STS, but a pressure valve to any overload of the STS...."

With regard to the need for a fifth Space Shuttle Orbiter, Under Secretary Aldridge said:

> "...with DOD priority, we [DOD] are confident that four Orbiters will satisfy DOD STS launch requirements during the 1990s. Therefore, a decision for a 5th Orbiter can only be justified for non-DOD purposes."

Under Secretary Aldridge also provided the following estimates of the relative cost to the Defense Department (in FY 85 dollars) of using various space launch systems:

- o Roughly $30 million per flight for modified Titan II launch vehicles (made up of $15 million in hardware costs and $15 million in launch operations costs),

- o About $114 million per flight for the Space Shuttle (made up of $54 million in "marginal cost" paid to NASA and $60 million in DOD contributions to "the fixed operating costs of the Shuttle, such as the Vandenberg Air Force Base launch and landing site"), and

- o About $122 million per flight for CELVs--excluding a Centaur upper stage--(made up of $98 million in hardware costs and $24 million in launch operations costs).

Jesse W. Moore, Associate Administrator of NASA's Office of Space Flight, summarized the annual launch capability of the Space Shuttle fleet in the 1990 time frame as follows:

- o A four Orbiter fleet could sustain a 24 per year flight rate, with an ability to surge temporarily to 28 flights per year,

- o A five Orbiter fleet could sustain 30 flights per year, and

- o A three Orbiter fleet (i.e., the situation that would exist with one of the current fleet of four Orbiters out of service) could sustain an annual launch rate somewhere in the range of 15-20 flights, and for periods of up to one year could surge to a launch rate range of between 20 and 24 flights per year.

On the subject of a fifth Orbiter, Mr. Moore testified that: "...it is difficult to support the need for a fifth Orbiter in the early 1990s." In terms of cost, he estimated that a fifth Orbiter could be started in FY 1988 and delivered in 1992 for $2.2 billion. Additionally, he noted that "several hundred million dollars" more would be required to enable other elements of the program to support an expanded launch rate of up to 30 flights per year.

During the classified closed session of the hearing on July 24, 1985, the subject arose of evolving technologies that may permit a jet engine powered "aerospace plane" or "transatmospheric vehicle" to take off from a conventional runway, go into orbit, and then return to a conventional runway. To more thoroughly cover this topic, Chairman Nelson requested that Robert Williams, Program Manager for the Transatmopheric Vehicle Program in the Defense Advanced Research Projects Agency (DARPA) to move from the audience to the witness table so that he could contribute to the discussion. Additionally, he was invited to testify at the next day's hearing along with Dr. Charles Buffalano, the Acting Director of DARPA.

These DARPA witnesses explained that there has been a culmination of breakthroughs in propulsion, materials, and thermal protection technologies that may make possible the development of a transatmospheric vehicle. The current plan is to invest $300 to $400 million in a two to three year ground test program to concentrate on advancing and demonstrating key engine, materials, and structures technologies. The next step would be to build and fly a small research vehicle employing these technologies. The DARPA witnesses indicated that this research vehicle would probably cost between $1.5 to $2.0 billion and could possibly be flying by 1992. After an extended flight test program, work could begin on an operational variant of the vehicle that could carry payloads of a size and weight equivalent to those carried by the Space Shuttle. The DARPA witnesses added that assuming the successful and timely completion of the developmental and flight test programs, the full-scale version of an operational system could possibly be flying by the year 2000.

Of particular interest was the testimony by the DARPA witnesses that a transatmospheric vehicle could potentially reduce by a factor of 100 the current cost of placing payloads into Earth orbit.

IV. Major Issues

During the three days of hearings, a number of major issues were addressed. This section summarizes the data and views presented on each issue. The issues are organized by topic, with one or more issues discussed under each topic. The information presented here is drawn from both the testimony given at the hearings and the witnesses' responses to followup written questions posed by Subcommittee Members.

A. Future Launch Demand

The focus of the first day of the hearings was on the demand for space launches during the 1990s. Prior to this hearing, there had been little or no public discussion of the number of launches that will be required to support Space Station and Strategic Defense Initiative activities.

For consistency, each witness was asked to project launch demands in terms of equivalent Space Shuttle payload bays full of cargo. In this way, the demands projected by each witness for different sectors of the space community could be directly combined to derive an estimate of total launch activity. General Kutyna noted that the one deficiency of this approach is that it inherently assumes "perfect manifesting" of the Space Shuttle. To the extent that the Space Shuttle's cargo bay is not fully loaded for each launch, additional flights will be required.

Prior to the start of the hearing, the four witnesses were asked to focus their testimony on different components of space launch demand as follows:

Mr. Lee: baseline trends in civil launch demands (excluding Space Station-related activities),

Mr. Culbertson: projections for Space Station-related activities,

General Kutyna: baseline trends in DOD launch demands (excluding SDI-related activity), and

General Abrahamson: projections for Space Defense Initiative-related activities.

The data presented by each witness is summarized in Section III of this report. By totaling their projections, an estimate of total launch demand for the first half of the 1990s is found to equal 32 Space Shuttle equivalents per year.

Witnesses were divided as to whether or not this estimate is more likely to overstate or understate true launch demand levels. General Kutyna thought the estimate could be low because the Space Shuttle is not always fully loaded for each launch. Such a situation is especially prone to happen when the Space Shuttle is used to launch a small satellite into a unique orbit that is incompatible with the desired orbits of all other satellites awaiting a launch opportunity.

Mr. Lee testified that the estimate is probably high, because historically actual launch rates are normally less than projected. He indicated that one cause of this situation is the delays that frequently occur in developmental programs. He also noted that the Defense Department currently schedules the launching of satellites intended to replace orbiting spacecraft at the point in time when there is a 50 percent probability that the orbiting spacecraft will have failed. Several DOD witnesses observed that operational military satellites have in fact been lasting longer than originally projected. Therefore, the launching of a replacement spacecraft is typically delayed until an orbiting satellite actually begins to fail--thus resulting in lower than projected launch rates.

General Kutyna noted that a study conducted for the Defense Department by the Aerospace Corporation concluded that, historically, DOD space launches average about 70 percent of the number that is projected a year or so in advance. On the other hand, Under Secretary Aldridge testified that, though this is true, the projected DOD launch rates presented by General Kutyna had already been discounted by 20 percent.

For civil launches, Mr. Lee testified that, based on historical experience, "an aggregate 10 to 15 percent reduction in the estimated number of flights is reasonable."

If it were assumed that a discount factor of 10 to 20 percent should be applied to the launch rate estimates presented by witnesses for the early 1990s, the total demand level of 32 Space Shuttle equivalents per year would be reduced to 26 to 29 launches per year.

All witnesses agreed that launch demand levels for the last half of the 1990s would be greater than the first half of the decade, but they also agreed that any specific estimates would be highly uncertain. Adding to this uncertainty are unknowns relating to: 1) the rate at which Space Station activities will expand; 2) the rate at which commercial development and use of space will materialize; and 3) whether or not SDI will ultimately be approved.

B. Adequacy of Existing Launch Capacity

The witnesses agreed that the existing fleet of 4 Space Shuttle Orbiters supplemented with the use of a few expendable launch vehicles (ELVs) should have no problem in supporting all of this nation's space launch requirements throughout the rest of the current decade. They also agreed that should capacity problems develop at a later date, they are most likely to arise in connection with Space Station and SDI activities. Mr. Walker added to this list the potential for rapid growth in commercial space ventures, especially in the area of materials processing.

Mr. Moore testified that during the early 1990s the existing 4 Orbiter Space Shuttle fleet should be capable of sustaining a continuous launch rate of 24 flights per year. Additionally, he indicated that the Orbiter fleet should be able to temporarily surge to a launch rate of up to 28 flights per year.

To this Space Shuttle provided capacity must be added the launch capacity that will be supplied by available expendable launch vehicles. Currently, the Defense Department has plans to procure and launch ten large ELVs, referred to as Complementary Expendable Launch Vehicles (or CELVs). These CELVs (also know as Titan 34D-7s) have a payload lift capacity equal to that of the Space Shuttle, so in terms of launch capacity each CELV launch is equivalent to a Space Shuttle launch. Present Air Force plans call for these CELVs to be launched at a rate of two per year from 1989 through 1993. Additionally, the Air Force plans on launching one or two converted Titan II ICBMs each year carrying small payloads into polar orbit. When used as space launch vehicles, these converted ICBMs have a payload capability equal to one-quarter to one-third that of the Space Shuttle.

Combining the launch capabilities of these systems, in the early 1990s, the space launch capacity of the United States should total about 26.5 Space Shuttle equivalents per year, in the early 1990s, with a temporary surge capacity of about 30.5 Shuttle equivalents per year. If use of the Titan 34D-7s ends in 1993 as currently planned, these capacity figures would drop to about 24.5 and 28.5 Shuttle equivalents per year, respectively.

When these capacity figures are compared with the launch demand projections for the first half of the 1990s presented in the previous section, it would appear that even if CELVs remain available for the full period of time through 1995, total available launch capacity will only be marginally capable of supporting the sustained launch demand of 26 to 32 Shuttle equivalents per year that is projected to be required. If launch demand for the latter half of the 1990s grows beyond these levels, it would appear clear that additional launch capacity will have to be made available for that time period.

All of the witnesses agreed that the Space Shuttle should be capable of providing for the bulk of U.S. space launch needs through the turn of the century. General Herres noted that even if each Orbiter has a lifetime of only 100 flights, the 4 orbiter fleet will suffice until about 2003. Dr. Mark commented that, historically, airframes last much longer than their original design lifetimes and he believes that the Space Shuttle will be no different and that it will remain available "indefinitely" or at least until it is replaced by a new generation of space launch vehicles, probably some time after the year 2000.

In addition to simple measures of launch capacity, the DOD witnesses testifed that national security space missions also required "flexibility and versatility" in the U.S. booster fleet. General Herres stated:

> "Expendable launch vehicles add dimensions to our inventory of boosters that would not be otherwise available if we depended solely on the Shuttle vehicle and the Shuttle series of vehicles alone. There is a risk reduction by depending on a separate kind of system that has different 'long poles in its tent,' so to speak, from those that exist with a single system."

General Kutyna expressed a similar sentiment:

> "Since our future launch requirements are so indeterminate at this time, one of our top level objectives is flexibility. We must have the ability to satisfy a dynamic range of lift requirements, launch rates and schedules. It is doubtful that a single launch vehicle will satisfy these requirements and it is likely that a family of vehicles may be needed."

Dr. Mark observed from his experience in the Defense Department that a principal concern of military users of space is maintaining operational control over some of their own launch vehicles. When asked how he felt about this comment, General Herres said:

> "Obviously, every operational commander would like to control as many of his resources as possible."

But he added that because of the expense of these systems: "...it is necessary to share utilization." And:

> "The Shuttle fleet seems to me to be too small, even if we have five [Orbiters]... to operate in a mode in which the users would have a significant amount of autonomy."

As a final consideration in this general area, Mr. Nelson, Mr. Brown, and Mr. Walker expressed strong concern that there is only a single 747 aircraft available to transport Orbiters across the country. Mr. Nelson noted that if for some reason this 747 were not available, it would take 8 months to modify another 747 to be capable of transporting Orbiters and this could have a serious impact on the operational launch capacity of the Space Shuttle fleet. Each witness echoed that this situation was of substantial concern to them. To solve this problem, Mr. Moore testified:

> "We are in the process of considering an engineering study and ordering of long lead parts that would put us in a posture of shortening the time required if we ever had a problem with our 747, to do the engineering on the mod's required, to buy the parts, the material, and get the mod's completed to equip a second 747.
>
> We have not made a decision and we are looking at that in my deliberations now on future year budgets -- the possibility of a second 747 or stopping with the engineering mod's and capability required to MOD a second 747 if, in fact, we needed it."

C. Consequences of Unavailability of an Orbiter

A concern related to the adequacy of available space launch capacity is the consequences that would result from the unavailability of an Orbiter. This unavailability could result from such circumstances as an Orbiter: 1) being rotated out of service for an extended period of time for a major overhaul, 2) undergoing repairs to correct damage sustained in a minor accident, or 3) being totally lost in a catastrophic accident.

If an Orbiter were to be unavailable for use for an extended period of time, Mr. Moore testified that the remaining 3-Orbiter fleet could surge to provide an annual launch rate of between 20 to 24 flights for a period of up to one year. He added, however, that a three-Orbiter fleet would have a sustained launch capability of only 15-20 flights per year. This would represent a significant reduction from the launch capacity of the current four Orbiter fleet. Further, if an Orbiter were lost in a serious accident, it would take an extended period of

time to replace the lost capacity with some other launch means. General Kutyna testified that the lead-time required to build an ELV is about 42 months. In like manner, Mr. Moore testified that it would take about 5 years to build a fifth Space Shuttle Orbiter. Additionally, once the replacement capacity became available, there would be a backlog of payloads awaiting launch.

Accordingly, in his opening statement for the last day of the hearings Mr. Nelson stated:

> "Under the current situation, the sustained downtime or total loss of a single Orbiter would cause a substantial reduction in this country's total launch capacity which could not be replaced for a period of at least 3 to 5 years. This would cause serious disruptions and delays in many space projects and endeavors.
>
> ...I believe that this country's space endeavors are too important to the national security and economic well being of the Nation for our launch capacity to be incapable of acommodating the unavailability of a single Orbiter. I hope that as the Administration focuses on this policy issue it will concur and begin to take the necessary actions to bring about its implementation."

Later, Mr. Nelson asked Under Secretary Aldridge and Mr. Moore if they agreed that there should be sufficent flexibility built into this country's launch capability so that it could accommodate the extended downtime or total loss of a single Orbiter?

Under Secterary Aldridge responded:

> "Yes sir. That's the case that we made precisely for a CELV at a slow launch rate during the '88 to '93 timeframe. That philosophy should be carried forth into the '90's."

Mr. Moore added:

> "I agree that there needs to be some kind of a capability in the event we do have some downtime in the Shuttle program with one of the Orbiters and we're left with a fleet of three Orbiters. I think that's something that we need to think very seriously about, and this country ought to make a decision on that particular point. I hope that situation never occurs, but you can't say that the probability is zero...."

D. Alternatives for Enhanching Space Launch Capability

During the hearings a number of alternatives for enhancing space launch capacity were discussed by the witnesses. These are summarized below.

1. Build a Fifth Space Shuttle Orbiter

The Science and Technology Committee and the Space Science and Applications Subcommittee have long supported the production of a fifth Space Shuttle Orbiter.[5]

The referenced reports, contain arguments that a fifth Orbiter can be justified either on the basis of likely demand that should develop during the 1990s, or as a backup vehicle should an Orbiter be lost any time before the year 2000 (when a "next generation" replacement to the Space Shuttle may become available).

With the exception of Dr. Mark, there was little support for building this vehicle among the witnesses at the hearing.

General Herres asserted that the time has passed during which the country should have built a fifth Orbiter, and argued that the resources that would be utilized to build the vehicle should instead be used to develop a transatmospheric vehicle.

Under Secretary Aldridge reasoned that four (or even three) Orbiters are sufficient to meet all DOD space launch needs and, since he asserts that the Defense Department would always have priority over all other users, additional Orbiters are not needed to support DOD space launch requirements.

Mr. Moore testified that on the basis of NASA's current demand projections, it is difficult to justify the expenditure of $2.2 billion to build the fifth Orbiter. He went on to add that if larger funding levels were available to NASA, the Agency "would not be against a fifth Orbiter," but with the budgetary constraints now faced by the Agency, "the fifth Orbiter does not fit within [NASA's] overall priorities."

---

[5](a) The Need for An Increased Space Shuttle Orbiter Fleet. Report, Committee on Science and Technology, U.S. House of Representatives, 98th Congress, Serial HH, December 1982.
(b) Authorizing Appropriations to the National Aeronautics and Space Administration for Fiscal Year 1984. Legislative Report #98-65, April 15, 1983.
(c) Authorizing Appropriations to the National Aeronautics and Space Administration for Fiscal Year 1985. Legislative Report #98-629, March 21, 1984.
(d) The National Aeronautics and Space Act of 1958. Report, Committee on Science and Technology, U.S. House of Representatives, 98th Congress. Serial EE, September 1984.
(e) Review of Space Shuttle Requirements, Operations, and Future Plans. Report, Committee on Science and Technology, U.S. House of Representatives, 98th Congress. Serial GG, October 1984.
(f) Authorizing Appropriations to the National Aeronautics and Space Administration for Fiscal Year 1986. Legislative Report #99-32, March 28, 1985.

2. Build Additional Complementary Expendable Launch Vehicles (CELVs)

About a year and a half ago the Defense Department began arguing for the need for an ELV with a payload carring capability equivalent to that of the Space Shuttle. As stated at the hearing by General Kutyna, this complementary expendable launch vehicle is required so that the most important national security payloads are not dependent on a single launch system for reaching orbit.

General Herres listed the following advantages offered by ELVs when used in conjunction with the Space Shuttle:

- o They provide an alternate launch capability suitable for use in crisis and conflict situations,
- o They provide an ability to dedicate a specific booster and payload to a launch pad for an extended period of time,
- o They free the Space Shuttle for use in those missions where its unique capabilities are required,
- o They provide for the continued maintenance of a launch vehicle industrial base, and
- o They provide some potential for a U.S. ELV to compete with foreign space launch systems.

Under Secretary Aldridge also noted that they provide "a pressure value to any overload of [Space Shuttle] capabilities."

To this Dr. Mark countered that "there is no technical reason why the entire U.S. space launch capability should not be vested in the Space Shuttle fleet."

He also expressed the opinion:

> "We are buying only marginally more reliability, and we are buying only marginally more flexibility. Neither one of these is worth the money we are spending on CELVs, in my judgment."

General Herres countered that in his view, the 10 CELVs being bought by the Defense Department would cost about the same as the total cost of the Defense Department making these 10 flights on the Space Shuttle. (As outlined in Section III of this report, the cost estimates provided by Under Secretary Aldridge project CELV launch costs at about $122 million per flight and Space Shuttle launch costs at about $114 per flight -- including DOD's contribution to the fixed operating costs of the Space Transportation System.)

Based upon the arguments made by the Defense Department, last February the President signed National Security Decision Directive 164 which gives Presidential approval for the Air Force to procure and launch 10 CELVs. At the hearings, several DOD witnesses were asked if additional CELVs would be procured beyond the 10 now being requested by the President.

General Herres testified that it is "too soon to say" and later added that "the first thing that needs to be settled is, what can we do with the Shuttle... I don't think it would make any sense at all to talk about buying more CELVs until that question is answered."

Under Secretary Aldridge stated that "as of now, we see no definitive need for CELV launches beyond the two per year rate in the 1988-1992 timeframe. However, as the 1990 missions and the Space Station and SDI requirements become better defined, we may indeed need to continue to build and fly additional CELVs beyond the 10 vehicles currently planned. The number of additional CELVs will be dependent upon these emerging requirements as well as the demonstrated flight rate of the Orbiter fleet."

3. Utilize Some Small Expendable Launch Vehicles (ELVs)

Within the past year the Defense Department has also begun to argue that there are some missions where the use of ELVs with a payload capability substantially less than that of the Space Shuttle is justified. Under Secretary Aldridge testified that he believes that it is more efficient to use ELVs rather than a dedicated Space Shuttle mission to orbit "a small launch-on-demand satellite" or "for placing a small spacecraft in a unique orbit."

General Herres stated that the current plan is to use existing Atlas ELVs through 1990 and then beginning in about 1988 to switch to converted Titan II ICBMs for missions where a small ELV is desirable. On average, one or two of these vehicles would be launched each year.

In response to a written question, the Defense Department added that the demand for small ELVs will be low enough that it would not be economical to consider maintaining more than one production line for such boosters.

Dr. Mark expressed his opinion that economic arguments could not support the continuation of even a single production line for small ELVs.

4. Develop and Use Large Heavy-Lift Expendable Launch Vehicles

Dr. Mark argued strongly in his testimony that the Defense Department should begin to develop a new class of heavy-lift ELV which employs Space Shuttle components. Such a vehicle would have a payload lift capability in the range of 100,000 to 200,000 pounds (compared to the

65,000 pounds that can be orbited by the Space Shuttle). He stated that such a vehicle will eventually be required to meet the payload lift requirements of the Strategic Defense Initiative program, and indicated that he believes that this vehicle should be used for all unmanned launches rather than the CELV planned by the Air Force.

Other witnesses agreed that a heavy-lift launch vehicle will probably eventually be required to support the SDI program, but disagreed that development of this class of vehicle should begin soon. For example, both Under Secretary Aldridge and General Abrahamson testified that it would take less time to develop such a booster than the payloads that it will eventually carry. Accordingly, they argued that it would be best to wait until these payloads are defined before beginning a new booster development. In this way the capabilities of the booster can be tailored to ensure that it is not too small or excessively large compared to the actual size of the payload. Under Secretary Aldridge also noted that at the present time no spacecraft being developed by the Defense Department is heavier than can be handled by either the Space Shuttle or the CELV now in development.

Finally, Under Secretary Aldridge testified that the Air Force estimates that the cost of each heavy-lift vehicle will be roughly twice the cost of a CELV. Therefore, he asserted that it will be substantially cheaper to use CELVs for the payloads now programmed to use this alternative to the Space Shuttle rather than employing heavy-lift vehicles to carry Space Shuttle-size payloads.

5. Develop a New Generation of Transatmospheric Vehicles (TAVs)

In Section III of this report it was noted that the Administration has plans to actively pursue the development of a revolutionary new generation of space launch vehicles that employ jet engines as the principal means of propulsion. The witness testimony at these hearings was generally very supportive of the TAV program.

Mr. Williams noted that "...if the numbers turn out to be real, we can talk in terms of on the order of one-sixth the gross weight of Shuttle and four to five times the payload."

And, "...if you could come anywhere close to the numbers we're talking about, you have got something on the order of two orders of magnitude reduction in the direct operating and support cost potential of the concept, primarly because it can be a .... fully reusable system."

General Herres testified that "this is a very exciting idea, and the military importance of being able to do the kind of things that this vehicle could do is, in my view, extraordinary. And I think we need to exploit this as quickly as we can afford to do that."

Mr. Moore noted that "... it seems to me that it [has] some promising objectives and some promising capabilities, and the country ought to look very hard at what it can offer...."

And, "... it sounds like there's a lot of potential, and we should be supporting that."

Dr. Mark agreed with pursuing a technology demonstration program, but felt that it should not be undertaken at the expense of supporting current needs. Accordingly, he raised several notes of caution, stating that, "one of the conceptual errors one can make in structuring a technology program is to say that an aggressive program in the face of very real unknowns is guaranteed to yield results. It isn't." And, in reference to a magazine article on single-stage-to-orbit vehicles, he indicated that "I think the implication is that this is easier to do than I think it really is."

There was some uncertainty as to when an operational TAV could be made available to either augment or totally replace the Space Shuttle. Congressman Walker stated that he had been led to believe that an operational TAV could be available by the mid-90s. This is a significantly important point because it would have a major impact on the likely adequacy of available space launch capacity throughout the decade of the 1990s.

After some discussion, the witnesses agreed that an operational TAV with the payload carrying capability of the Space Shuttle could not be available before the year 2000:

> Dr. Mark said, "You're talking somewhere beyond the year 2000 for the first flight."
>
> General Herres agreed, saying "I would hope that we can...be moving towards something by the turn of the century."
>
> Mr. Williams testified, "...for the things that your Committee is considering here...we're talking post-2000...."
>
> Finally, Mr. Moore in response to a written question stated, "We believe that the next generation of space transportation vehicles will not be operational until about the year 2000."

E. National Space Transportation and Support Study

Several witnesses made reference to the joint NASA/DOD National Space Transportation and Support Study that was just getting underway. General Abrahamson explained that:

> "The study will identify a potential space mission requirement for both national and civil government needs for the 1995 period and beyond; define the transportation infrastructure options to satisfy these missions; identify launch vehicle technologies that can be made available; and finally, identify the firm requirements.

> The study will look to all aspects of launch capabilities, including operations, maintenance and logistics, both in space and on the ground. The Administration is confident that the recommendations provided by the study will permit the U.S. to maintain continued access to space and world leadership in space transportation.
>
> The final report is scheduled for May of 1986. From this report a broad technological investment program for future national requirements will be provided."

At several points during the hearings Mr. Nelson complained that the current situation appears to be one where "decisions are being made by indecision" (e.g., key decisions relating to U.S. launch capacity -- such as whether or not to build a fifth Space Shuttle Orbiter -- continue to be delayed and may well be overtaken by events). He also noted that each major user has been guilty of looking only at their "own individual requirements" and not taking a "national perspective" in balancing future user demands with available capability. Accordingly, he expressed hope that some definitive decisions and plans will emerge from the current joint NASA/DOD study effort.

Finally, throughout the hearings, Members expressed concern about the timing and scope of the current joint NASA/DOD study. These problems were discussed with and among several of the witnesses. As a result of these discussions, at the last day of the hearings Under Secretary Aldridge and Mr. Moore proposed a modification in both the content and the schedule of the study. Specifically they were in agreement on the following changes:

- The timeframe for the study would be moved forward from 1995 to 1992.
- The study would identify and thoroughly evaluate alternative launch vehicles and facility procurement and operating options that could provide sufficient space launch capacity so that the sustained unavailability or total loss of a single Space Shuttle Orbter could be accommodated with no major impact on the U.S. launch manifest of national security, civil government, foreign, and commercial payloads.
- The appropriate congressional committees would be briefed on the tentative conclusions of the study (especially those that relate to the early and mid-1990 timeframe) by the time that the President's FY 1987 Budget is transmitted to the Congress.

F. Priority Allocations Between Defense and Civil Users

On several occasions during the hearings, DOD witnesses made statements that indicated a fervent belief that national security payloads will always have priority over the payloads of all other users. For example, Under Secretary Aldridge stated:

> "...with DOD priority, we are confident that 4 Orbiters will satisfy DOD [Space Shuttle] launch requirements during the 1990s. Therefore, a decision for a 5th Orbiter can only be justified for non-DOD purposes."

In like manner, General Herres testified:

> "...if an Orbiter is lost or if one or more vehicles are unable to fly for an extended period.... Our assumption is that these risks will be borne primarily by non-DOD users."

Although he did go on to add: "...it is obvious that DOD cannot be insensitive to the impact of this kind of situation."

This belief also appeared to be accepted by NASA in that Mr. Moore and Mr. Lee testified that national security missions would have "top priority" if there were to be some "downtime" in the Space Shuttle fleet.

When this issue first arose, Mr. Walker questioned:

> "Four Orbiters can take care of your requirements, but does that mean you're going to throw everybody else off?...and we're going to have a period of time where no one will get to fly except the Air Force?"

To this he concluded:

> "Well, the fact is that Congress probably isn't very likely to let [that happen] in peacetime, are we? To just totally throw out everything in order to satisfy the Air Force's need?"

Mr. Nelson added:

> "It is conceivable that in peacetime circumstances, with something spectacular happening in the way of materials processing...say pharmaceutical manufacturing, that it's conceivable that the Congress would give the preference to that civilian access to space instead of the DOD access."

The only government witness to yield any ground during the hearings on this issue was General Herres who stated:

> "And so, I agree with you 100 percent. I think we are going to have a real problem if we depend solely on the assumption that we are going to be able to call the priorities."

○